SOILS AND GROUND WATER

SOILS TEXTURE AND GROUP DETERMINATIONS

Determining Soil Textural Classifications

Soil texture is the proportion of three separates: sand, silt and clay. It is one of the most important characteristics of soil for water movement because of its relationship to pore size, pore size distribution and continuity of pores. Permeability, aeration and drainage are all related to the soils ability to filter and adsorb pollutants. Sizes of the major separates are shown in the table below.

TABLE 1

Sizes of Mineral Soil and Rock Fragments

Material	Equivalent Diameter	Passes Sieve #
Clay	Less than 0.002 mm	425
Silt	0.002 to 0.05 mm	270
Very Fine Sand	0.05 to 0.1 mm	140
Fine Sand	0.1 to 0.25 mm	100
Medium Sand	0.25 to 0.5 mm	50
Coarse Sand	0.5 to 1.0 mm	16
Very Coarse Sand	1.0 to 2.0 mm	10
Gravel	2.0 mm to 7.5 cm	3"
Cobbles	7.5 to 25.4 cm	10"
Stones	25.4 to 61 cm	24"
Boulders	Greater than 61 cm	-

The Soil Textural Classification used by Idaho has been adopted from the U. S. Department of Agriculture. Soils textures of proposed soil absorption sites are determined according to these guidelines. Once the textures have been determined then the soil design groups may be specified for the design of the absorption system. Characteristics of each soil texture are shown in Table 2.

Refer to Figure 1 and Table 3 for summaries of the soil particle distributions and percentages in each of the textures.

TABLE 2. Soil Textural Characteristics.

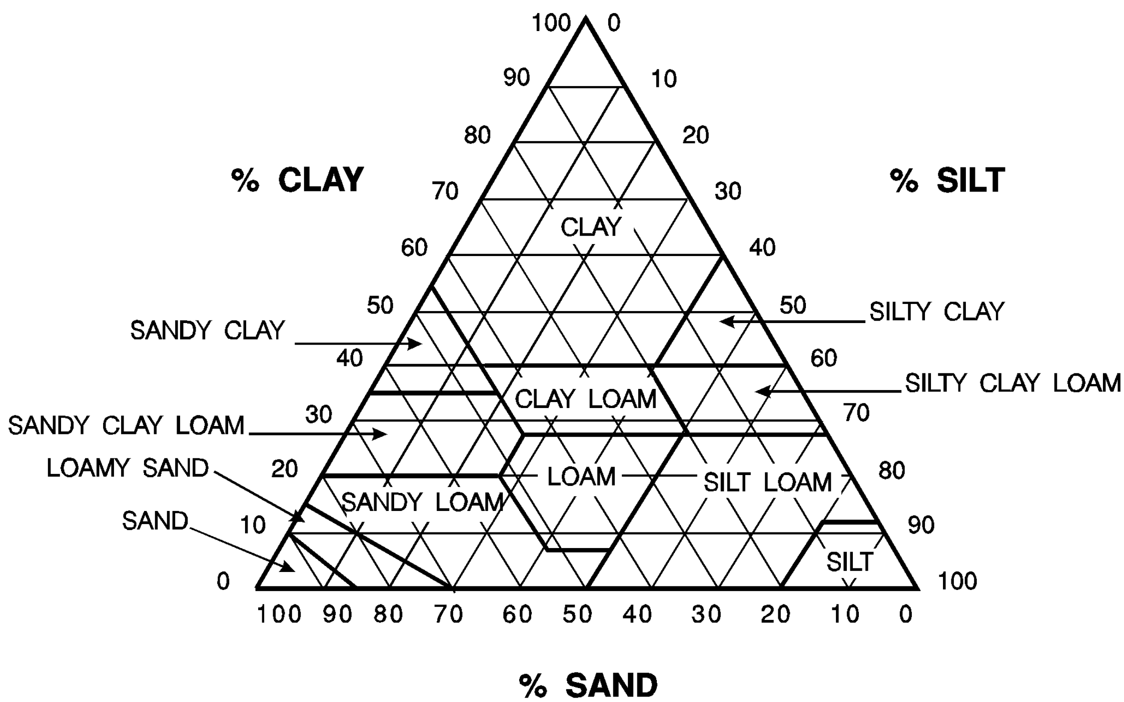
Soil Texture	Visual Detection of Particle Size General Appearance of Soil	Squeezed By Hand and When Air Dry	Pressure Released When Moist	Ribbon Between Thumb and Finger
Sand	Soil has a granular appearance, loose, gritty grains visible to the eye. Free flowing when dry.	Will not form a cast. Falls apart easily.	Forms cast which crumbles at least touch.	Cannot ribbon.
Sandy Loam	Somewhat cohesive soil; aggregates easily crunched. Sand dominates but slight velvet feel.	Cast crumbles easily when touched.	Cast will bear careful handling.	Cannot ribbon.
Loam	Uniform mixture of silt, clay, and sand. Aggregates crushed under moderate pressure. Velvety feel which becomes gritty with continued rubbing.	Cast will bear careful handling.	Cast can be handled freely.	Cannot ribbon.
Silt Loam	Quite Cloddy when dry. Can be pulverized easily to a fine powder. Over 50 % silt.	Cast can be freely handled. Flour-like feel when rubbed.	Cast can be freely handled. When wet, flows into puddle.	Will not ribbon, but has slight plastic look.
Silt	Over 80 % silt with little fine sand and clay. Cloddy when dry pulverizes readily to a flour-like powder.	Cast can be freely handled.	Cast can be freely handled. Puddles readily. "Slick" Feeling	Ribbons with a broken appearance.
Silty Clay Loam	Hard lumps when dry, resembling clay. Takes strong pressure to break the lumps.	Cast can be freely handled.	Cast can be freely handled. Can be worked into a dense mass.	Forms thin ribbon which breaks easily.
Clay	Very fine textured soil breaks into very hard lumps that take extreme pressure to break.	Cast can be freely handled.	Cast can be freely handled. "Sticky" feeling.	Forms long, thin ribbons.

Determining Soil Textural Classifications

TABLE 3. Soil Textural Proportions.

	Sand	Silt	Clay
Sand	> 85 %	< 15 %	< 10 %
Loamy Sand	70 to 90	< 30	10 to 15
Sandy Loam	43 to 85	< 50	< 20
Loam	23 to 52	< 50	7 to 27
Silty Loam	< 50	50 to 88	< 27
Silt	< 20	> 80	< 12
Sandy Clay Loam	45 to 80	< 28	20 to 35
Clay Loam	20 to 45	15 to 35	27 to 40
Silty Clay Loam	< 20	60 to 73	27 to 40
Sandy Clay	45 to 65	< 20	35 to 55
Silty Clay	< 20	40 to 60	40 to 60
Clay	< 45	< 40	> 40

FIGURE 1. USDA Soil Textural Triangle.



Basic textural names may be modified if the soil mass contains 15 to 95% of stones, cobble or gravel by adding the name of the dominant rock fragment:

Gravelly or stony = 15% to 35% of the soils volume is rock fragments.

Very gravelly or very stony = 35% to 60% of the soils volume is rock fragments.

Extremely gravelly or extremely stony = 60% to 95% of the soils volume is rock fragments.

95% or more should take the name of the geological type, such as granite, gneiss, limestone, or gravel.

Design Soil Groups and Subgroups

This section is provided as a guide to field environmental health personnel in making technical allowances for standard systems and for Health Departments to use in selecting alternative systems. The required absorption area of a subsurface disposal system depends upon the texture of the soils that surround that system. In a similar manner, required separation distances between the disposal and features of concern, such as wells, surface water, and groundwater, depend upon the texture of the soils. Soils surrounding the system and those below it may not be the same.

The soil design group or subgroup used for the purpose of determining both the minimum effective soil depth and separation category (separation distances) is the one describing the finest textured soils at the sides of the drainfield trenches and beneath them for the effective depth.

TABLE 4. Soil Textural Classification Design Groups.

Design soil group	Design soil Subgroup	Soil Textural Classification	USDA Field Test Textural Classification
A	A-1	Medium Sand	30-60 Mesh
	A-2a	Medium Sand	Poorly Graded
	A-2b	Fine Sand Loamy Sand	Sand 60-140 Mesh Sand
B	B-1	Very Fine Sand Sandy Loam Very Fine Sandy Loam	Sand 140-270 Mesh Sandy Loam Sandy Loam
	B-2	Loam Silt Loam Sandy Clay Loam	Silt Loam ($\leq$ 27 % Clay)
C	C-1	Silt Sandy Clay Loam Silt Clay Loam	Silt Loam Clay Loam ($\geq$27% Clay) Clay Loam
	C-2	Clay Loam	Clay Loam

All other soil textures and some soil features (Gravel, Coarse Sand, All Clays, Organic Muck, Claypan, Hardpan and Duripan) are unsuitable for installation of a standard drainfield system.

Soil Design Subgroup Corrections

A soil will be raised or lowered in design subgroup as indicated in this section: (**Subgroup correction is to determine application rate only**, it will not change surface water or groundwater separation requirements).

1. Porous silt loams and soils with strong vertical structure should be raised one soil subgroup for design purposes.
2. A soil with moderate or strong platy structure should be lowered one subgroup for design purposes.
3. A soil should be lowered one subgroup if 35% to 60% of its volume is rock fragments (very gravelly, very stony).
4. A soil should be lowered by two subgroups if 60% to 95% of its volume is rock fragments (extremely gravelly, extremely stony).
5. A soil with 95% or greater rock fragments is unsuitable as an effective soil for subsurface sewage disposal.
6. A uniform fine and very fine sand (blow sands for example) should be lowered two (2) subgroups for design purposes. Soils that qualify for this modification have a Coefficient of Uniformity less than three (C_u<3.0).

<u>Medium Sand</u>

The following definitions may be used to determine if a soil texture is a medium sand:

1. Conforms to the gradation requirements of ASTM-C-33 and less than 2% passes a # 200 sieve:

Sieve Size	Percent (%) Passing
4	95-100
8	80-100
16	50-85
30	25-60
50	10-30
100	2-10
200	<2

2. Conforms to the USDA definition of a medium sand:

Sieve Size	Millimeter Size	Percent (%) Passing
4	2-10	100
10	1-2	75
16	0.1-1	50
140	0.05-0.1	0-15

3. A sand with a mean particle size (D_{50}) of no more than 0.5 mm and a Coefficient of

Uniformity (C_u) of 8 or greater has been shown to sustain a biological mat and will be acceptable in systems under continual use.

SEPARATION GUIDELINES

Effective Soil Depth to Porous Layers or Groundwater.

The following table provides guidance for determining effective soil depth from the bottom of absorption fields to very porous layers or to normal high groundwater.

TABLE 5
Minimum Effective Soil Depth, in Feet, by Soil Design Subgroup To the Limiting Layer

Limiting Layer	Soil Design Subgroup					
	A-1	A-2	B-1	B-2	C-1	C-2
Fractured Bedrock or Other Porous Layer	6	5	4	3	3	2 ½
Normal High Ground Water	6	5	4	3	3	2 ½
Seasonal High Ground Water	1	1	1	1	1	1

Effective Soil Depths to Impermeable Layers

The following guidance may be used to determine the effective soil depth below absorption fields to impermeable layers, such as dense clays or caliche.

TABLE 6
Effective Soil Depth, in Feet, to Impermeable Layers

Percent Slope	Acres				
	1	2	3	4	5 or more
20	3.0'	2.8'	2.5'	2.3'	2.0'
16	3.2'	2.9'	2.6'	2.4'	2.0'
12	3.4'	3.1'	2.7'	2.4'	2.0'
8	3.6'	3.2'	2.8'	2.5'	2.0'
4	3.8'	3.4'	2.9'	2.5'	2.0'
0	4.0'	3.5'	3.0'	2.5'	2.0'

Conditions of approval:

1. The impermeable layer is that soil or geological feature that is less permeable than a

C-2 soil. The layer must be contiguous and unbroken beneath the absorption field and its replacement area for at least 10' in any direction from these sites.

2. Adjacent lots are of equal size or larger.

3. This guidance is applicable to standard systems and capping fill trench alternatives.

4. Minimum distance to a property line on the down-slope side of the absorption field and its replacement area must be at least 10 feet.

5. The lateral hydraulic conductivity of the effective soil should be such as to transport the combined precipitation and wastewater flow through the soil without surfacing.

CRITERIA FOR REDUCTION IN SEPARATION DISTANCES TO PERMANENT WATER

Rule Set Back	Soil Class	Soil Reduction	Vertical Soil Depth Above Water: >25' and Depth to Limiting Layer: >10'	Maximum Setback Reduction	Minimum Distance to Surface Water
300'	A-1	0	25'	25'	275'
300'	A-2	25'	25'	50'	250'
200'	B-1	0	25'	25'	175'
200'	B-2	25'	25'	50'	150'
100'	C-1	0	0	0	100'
100'	C-2	0	0	0	100'

The distance to permanent surface water may also be reduced to not less than 100' for all soil types when it can be demonstrated that:

1. The surface water is sealed so that there is no movement of groundwater into the surface water body or:

   The surface water body is discharging into the groundwater and:

2. There are no limiting layers between the elevation of the drainfield and the elevation of the surface water.

Each site should be reviewed on its own merits. Additional criteria such as population density and watershed characteristics, must be examined before an allowance is granted. Alternative systems may be required.

No additional technical allowance may be granted without a formal variance procedure.

STANDARD PERCOLATION TEST

The use of the percolation test is for checks on site surveys and soil analysis data ONLY. It is not to be used as the sole determiner of a proposed disposal site's infiltrative capability. The following outlines a procedure for making a standard percolation test.

1. Dig or bore a hole with horizontal dimensions of six (6) to eight (8) inches and with vertical sides to a depth of at least eight (8) inches in the zone of anticipated soil absorption.

2. Carefully scarify the bottom and sides of the hole with a knife or other device to remove any smeared surfaces.

3. Place about one (1) inch of coarse sand in the bottom of the hole to prevent scouring and sediment. A small section of standard four inch diameter perforated drain pipe is handy to prevent water splash on the hole sidewall.

4. Fill the hole with at least eight (8) inches of water and allow the soil to presoak at least four (4) hours. It is preferable to let the soil soak overnight. If the soil contains greater than 27% clay the soak period should be extended to 48 hours. The water must be clear, free of organics, clay or high sodium content.

5. Measurement procedure. In soils where:

   a) water remains in the hole after the presoak period, adjust the water depth to six (6) inches. Measure the drop in water level every thirty (30) minutes. Continue the test until the last reading is the same as the previous reading or four (4) hours, whichever occurs first.

   b) no water remains in the hole after the presoak period, add water to bring the depth to six (6) inches. Measure the drop in thirty (30) minute intervals, refilling the hole to the six (6) inch depth after each thirty (30) minute reading. Continue the test until the last reading is the same as the previous reading or four (4) hours, whichever occurs first.

   c) the first six (6) inches of water soaks away in less than thirty (30) minutes, the time interval between measurements should be ten (10) minutes.

6. Calculations:

$$\text{Percolation Rate, Minutes/inch} = \frac{\text{Time, in Minutes}}{\text{Water Drop, in Inches}}$$

7. At least two percolation tests should be run on each site, one test at each end of the proposed drainfield and in the zone of the effective soil depth.

8. The conversion of percolation rates to effluent application rates is approximate only, since the mechanism of hydraulic flow in the soil is dissimilar, especially in older, steady-state drainfields. Approximate comparisons are as follows:

TABLE 7

Soil Class	Soil Type	Percolation Rate, minutes/inch (1)	Application Rate gals/day/ft^2 (2)
NA	Gravel, Coarse Sand (3)	< 1	Not Suitable
A-1	Medium Sand	1 - 3	1.20
A-2a	Medium Sand, Poorly graded	4 - 5	1.0
A-2b	Fine Sand, Loamy Sand	6 - 15	0.75
B-1	Sandy Loam	16 - 30	0.60
B-2	Loam, Silt Loam	31 - 60	0.45
C-1	Sandy or Silty Clay Loam (4)	45 - 60	0.30
C-2	Clay Loam (4)	61 - 120	0.20
NA	Clays, Organic Muck, Duripan, Hardpan, Claypan	> 120	Not Suitable

(1) Estimates only.

(2) Application rates are for domestic wastes. A safety factor of 1.5 or more should be used for wastes of significantly different characteristics.

(3) See medium sand definition for a material that may be acceptable for use.

(4) Soils without expandable clays.

Evaluating Fill Material At Septic System Sites

Over time, precipitation and/or irrigation causes compacting of a fill, which may give it similar characteristics to that of the natural soils. Idaho has a wide range of precipitation, ranging from about 7 inches to near 80 inches. Differences in precipitation affects the rate and amount of compaction. Normal compaction will usually take at least 10 years to occur, depending on soil texture, fill depth and precipitation. Fill in low precipitation zones may never become naturally compacted enough to prevent settling in the drainfield area. Supplemental spray irrigation water can be used to aid settling where natural precipitation is not adequate. Generally, fill must be adequately saturated by irrigation for a minimum of 5 years to assure natural settling. If fill, other than sand, is loose or if it can be easily dug out by a gloved hand, then adequate settling has not occurred. Ideally, potential drainfield sites in fill should be planned 5-7 years in advance. Adequate depth and area should be planned and the site should be leveled prior to beginning the settling period.

NATURAL SETTLING OF FILL
OVER A 10 YEAR PERIOD

Soil Class	Depth of Moisture Penetration and Settling in Inches		
A	40	60	120
B	30	48	60
C	20	30	40
	7 - 16"	16 - 24"	> 24"
	Precipitation Zones		

Judgement in site evaluation will be necessary when layers of different textures occur. If a fill has a continuous horizontal layer of a finer textured soil, the settling should be calculated for the most restrictive soil. As an example, most of a fill is an A soil but a continuous layer of C soil occurs at 20 inches or less in a 7 to 16 inch precipitation zone. The fill in this situation should be considered a C soil. If the layer occurred at 30 inches then the depth between 30 and 40 inches may lack natural compaction.

Prior to placement of any fill, the natural ground surface should be scarified or plowed to a depth of 6 to 8 inches. This will increase stability and avoid the problems associated with a layer of organic material.

The original soil should not have been compacted prior to the placement of fill. Compaction can easily happen at construction sites if equipment, or other types of vehicles have been operated during periods when the site was wet. On sloping areas, preventing compaction is very critical because saturation zones can develop just above the compacted layer, creating stability problems. Loose soils with significant amounts of volcanic ash are particularly susceptible to compaction.

Sites should be avoided where fill has been dumped in piles for a long period and then leveled out. This will cause differential settling. The calculation of settling time will begin after leveling.

One way to check for compaction is to run a knife or geology pick point vertically on the face of a pit. Depth of penetration should be about 1/2 to 1" into the soil. Changes in resistance to the movement of this sharp object across the soil horizon is an indication of compaction. Very distinct platy structure or high bulk density is also an indication of compaction.

Fills of a different texture than the underlying natural soil can have stability problems on slopes if the underlying soil has a finer texture by 2 subgroups and a potentially slower permeability. Deep mixing of the fill with the top 12 inches of the native soil may help alleviate the problem on slopes less than 15%.

Demolition material; stumps, trash, large rock, in fill may make the site unsuitable.

If the fill is thin, less than 24 inches, the system may be in the natural soil. Guidelines for cap and fill systems will apply. Because of their greater variability, fills will require more extensive on-site investigation to determine the existence of restrictive layers, inclusion of stumps, demolition materials, etc.

This section is intended to provide general information for property owners to consider when filling a site and it is not an approved alternative design.

GROUNDWATER LEVEL

From the Static Water Level. Groundwater levels can be established by recorded observations of the changes in elevation of the groundwater's surface in a hole or well over a period of time:

1. Newly excavated holes or installed wells should be left undisturbed for 24 hours prior to observing the groundwater's surface elevation.

2. Permanent wells should be cased, with perforations in the casing throughout the anticipated zone of saturation. An idealized monitoring well for observing groundwater of less than 18' deep is shown in Figure 2.

If a permanent well is to be used for water quality monitoring also then it should be:

1. Purged or otherwise developed to eliminate installation contamination and silt build-up.

2. Provided with a ground water seal at the annular space between the casing and natural ground to prevent surface water from entering the groundwater along the exterior of the casing.

From Soil Condition. If the static groundwater level cannot be determined but its presence at some time in the year is suspected, its level can be predicted by looking for the presence of:

1. Reddish-brown or brown soil horizons with gray mottles, that have a chroma of two or less, and red or yellowish-red mottles;

2. Grey soil horizons that have a chroma of two or less, or gray soil horizons with red, yellowish-red, or brown mottles;

3. Dark colored highly organic soil horizons; or

4. Soil profiles with concentrations of soluble salts at or near the surface of the ground.

Care must be exercised in interpreting soil conditions as an indicator of high groundwater. Mottling may be the artifact of past groundwater from geologic time. Some soils do not readily indicate mottling, especially those with high ferric (Fe^{+++}) iron content and in areas with newly-established water tables or where the brown color is from iron bacteria.

Figure 2. Shallow Ground Water Monitoring Well Design.